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DESIGN OF SOLAR POWERED MUD POT AIR COOLER

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Abstract- *Development of generation & increase in population & higher living standards have consequences a high demand of electricity. Eventually energy shortage & huge revenue as well as global environmental problems has been arising.*

The present air-cooling methods are evaporative cooler; air conditioning, fans and dehumidifiers, but running these products need a source called electricity. The Producing of electricity is ultimately responsible for hot and humid condition i.e., global warming. In hot and humid conditions, the need to feel relaxed and comfortable has become one of few needs and for this purpose utilization of system like air-conditioning and refrigeration has increased rapidly.

These systems are most of the time not suitable for village due to longer power failure durations and high cost of products. Solar power systems being considered as one of the alternatives towards more sustainable energy system. This technology can efficiently serve large latent loads and greatly improve air cooling quality by allowing more ventilation while tightly controlling humidity. This project review solar powered mud pot air cooler for residential and domestic applications.

Technology is also being modernized due to increasing modernization. So, we have done this venture using the same technology like (Solid Works, Catia). These softwares are easy to handle and more convenient to design.

Key Words: Solar Panel, Charge Controller, Battery, Inverter, Fan, Mud Pot.

1.INTRODUCTION

This project designed for human comfort condition. In summer (hot) and humid condition feel uncomfortable because of hot weather and heavy humidity. So, it is necessary to maintain room temperature condition in thermal manner. Thermal comfort is determined by the room's temperature, humidity and ventilation of air. Radiant heat (hot surface) or radiant heat loss (cold surface) are also important factors for thermal comfort. To overcome this problem & to reduce the radiant heat, we are designing solar operated mud pot air cooler to maintain the thermal room temperature. The temperature in a house is based on the outside temperature and sun loading.

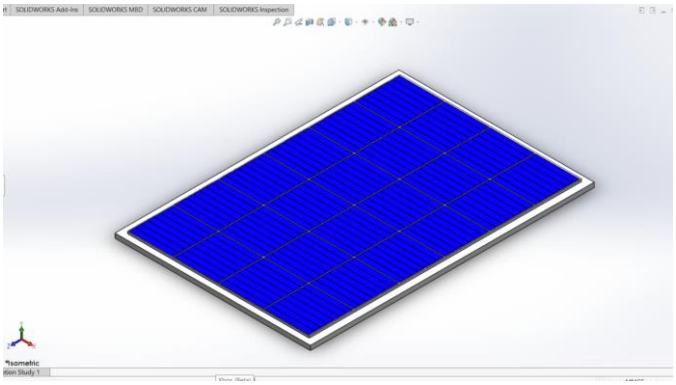
Basically, normal human body temperature is higher than room temperature. Need of such a source which is much abundantly available in nature, which does not affect on earth. There is only one thing which can come up with these all problems is solar energy. We are utilizing this natural energy to reduce the global warming.

1.1 Basic working of Solar Panel

A Solar Panel is device that can be used to generate energy from the sun light. The solar cell technology is fastest growing power generating technology in the world. Solar Panels are used to absorb the sun energy via solar cell and convert it into Direct current

Fig-1: Solar Panel

Panels work typically made up of anti reflective glass & solar cells made of sand, the second most abundant element on the earth. Each Solar cell is made up of wafer-thin layers with semiconductor material adders the layer on the top. It has negative charge & bottom



layer has a positive charge therefore when the sunlight hits the cells, these cells are exciting electrons in the top layer allowing the flow of electrons which is the creation of an electrical current. Solar panels create DC electricity but since electrical appliances use AC electricity and inverter will change the DC electricity to AC. The only moving part in solar cells are electrons and they all go back to where they came from. Nothing gets worn out used up or spent solar panel lasts for decades. If solar panels are tilted to at least 10° they'll self-clean when it's raining.

1.2 Principle of solar panel

A photovoltaic cell is also called a solar cell. It is a semiconductor device which converts sunlight into DC power using the photoelectric effect. Practically, all solar cells are photodiodes made of semiconductor material like silicon. A solar cell works in three steps:

Photons in the sunlight hit the solar cell and are absorbed by the semiconductor material.

Negatively-charged electrons are knocked off from their atoms and start flowing in the same direction to produce electric current.

A typical silicon solar cell can produce up to 0.5 V and current up to 6 A. Thus, its maximum power is 3 W.

Since the output of a single solar cell is very small, a large number of solar cells are interconnected to form a solar module, combination of solar modules is called panel and combination of panels is called solar array. It is done to get the required power output from a PV system.

When the solar cells are connected in series their voltage increases as much as the number of cells connected in series. But the current remains the same. When cells are connected in parallel, voltage remains constant, same as that of one cell but current gets multiplied. The cells, modules or panels can be connected in parallel only if their voltages are the same.

2. BATTERY

A battery is device that stores chemical energy and converts it into electrical energy. The chemical reactions in battery involve flow of electrons from one material (electrode) to another, through and external circuit. The flow of electrons provides an electric current that can be used to do work to balance the flow of electrons. Charged ions also flow through and electrolyte solution that is in contact with both electrodes. Different electrodes and electrolytes produce different chemical reactions that affect how the battery works, how much energy it can stores and its voltage.

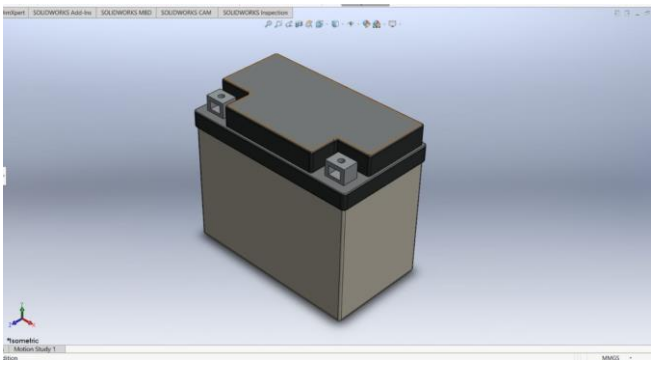


Fig-2: Battery

For storage of electric energy i.e., AC. We are going to use 10 AH, 12 V battery for running 35-Watt fan. For a purpose this battery could supply 35-Watt energy to fan for 14 Hours.

2.1 Inverter

Inverter acts as main source of Power supply in solar unit. An inverter is a power electronic device that changes direct current (DC) to alternating current (AC). The resulting AC frequency obtained depends on the particular device employed. Inverters do the opposite of "converters" which were originally large electromechanical devices converting AC to DC. The input voltage, output voltage and frequency, and overall power handling these all factors are depend on the design of the specific device.

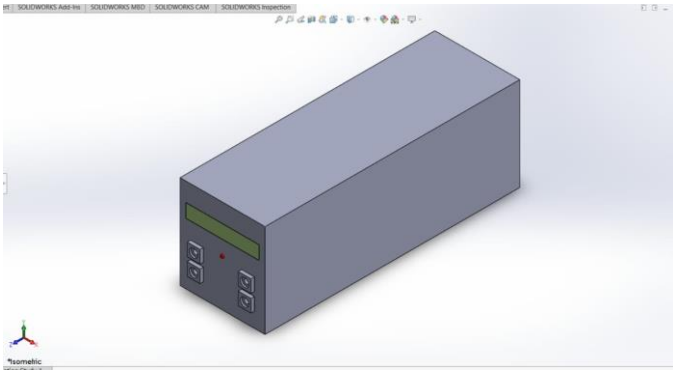


Fig -3: Inverter

The inverter does not produce any power; it uses the power provided by the DC source. A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry.

2.2 Fan

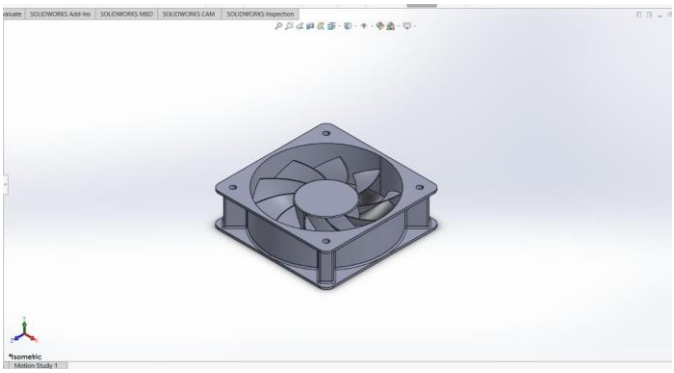


Fig -4: Fan

For the purpose of air circulation in Mud Pot, we are using this fan for generating cooling effect to reduce the room temperature. This fan is usually working on AC supply and that supply is given from a

Solar panel > Battery > Inverter > Control Unit > Fan.

2.3 Mud pot

Mud pot is made up of Slurry Soil made by Craftsman according to our requirements of size and shape. But in this purpose, we are using standard size of Mud pot that is 14-20 liters of water capacity, and this mud pot acts as main component in this project. As well as it works as main cooling medium of this project.

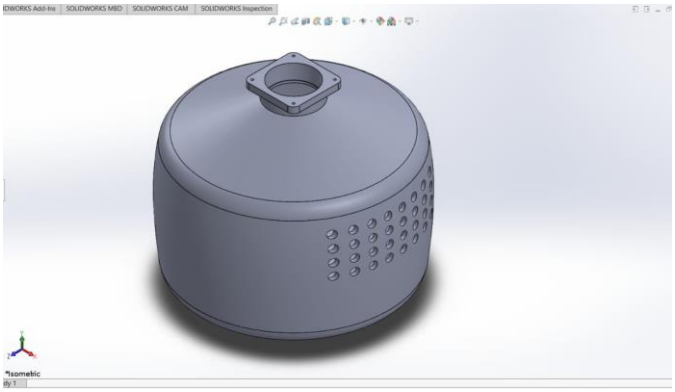


Fig- 5: Mud Pot

Basically, Mud pot is porous in nature so rate of cooling as compare to other medium is bit high, that's why it helps to reduce the room temperature. As result this pot gives a high rate of cooling effect, also it is very affordable in price so anyone can buy.

3. DESIGN PROCEDURE AND CALCULATION

This system designed according to the requirements, by considering engineering principles & different concepts is explained.
In design calculation we are using solar panel, battery, fan and mud pot. The following calculation is of solar panel, battery and mud pot required as capacity of water stored.

Selection criteria: Heat transfer between water and the air is given by following equation,

$$M_w*(T_1-T_2) = v/vs_1[(ha_1-ha_2) -(w_1-w_2)\ T_2) \ \ldots\ldots\ldots (1)$$

Where,
M_w – Mass of water entering in to the mud pot per minute.
V – volume of air (m^3) entering into the room per minute
V_s – Specific volume of air entering into the cooling room.

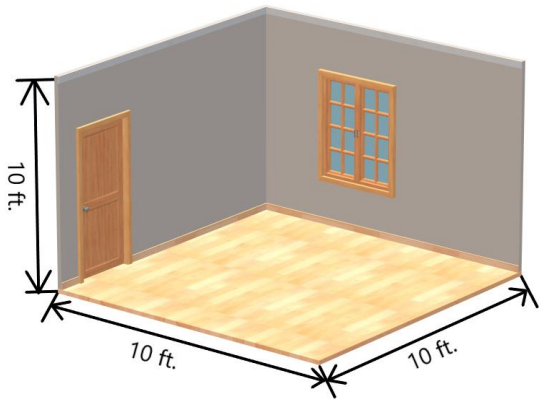


Fig- 6: Room Dimensions

ha – Enthalpy per kg of dry air at T_1
ha_2 – Enthalpy per kg of dry air at T_2
w_1 - Mass of water vapor per kg of dry air at T_1
w_2 – Mass of water vapor per kg of dry air at T_2

Considering,

T_1= 30^0c

T_2=25^0c

Relative humidity = 60%

M_w = 2kg of water per minute (assume)

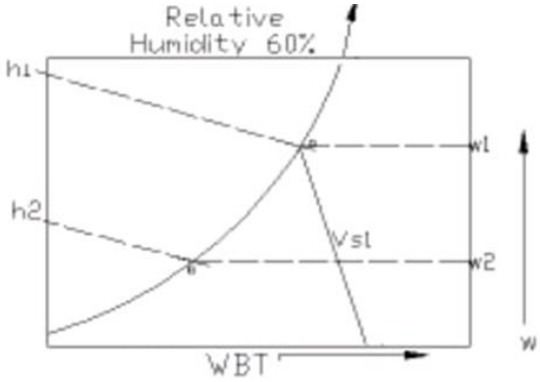


Fig-7: Psychometric Chart

From Psychometric chart

h_{a1} =72.5 kg of dry air

= 17.31kcal/kg

h_{a2}=56 KJ/Kg of dry air

= 13.37 kcal/ kg

w_1= 0.016 grams / kg of dry air

w_2= 0.012 grams / kg of dry air

V_{s1}= 0.880 m^3 / kg

Substituting above all values in equation…. (1)

2*(30-25) = V / 0.880 [(17.31- 13.37) – (0.16 – 0.012) * 25]

V = 2.291 m^3 min ~ 2.5 m^3 / min

The fan capacity is 2.5 m^3 / min is selected.

3.1 Design for solar panel and battery

Fan specification: 220v

50Hz,

35W

1400 rpm

0.35 Amps

To run 35-Watt fan for 1 hr. It will take 35*1 = 35 wh from the battery.

10 AH-12 v battery the watt hours in given by

V = 12v, I = 40 Ah

P = (V) * (I)

P = (12) * (40)

P = 480 wh

So, the 35w fan runs is given by,

hr. = (P)/ (Fan capacity)

hr. = (480)/ (35)

hr. = 13.71 ~14h

This battery could supply 480 wh power to fan for 14 hours.

To calculate the energy, it can supply to the battery, multiply watts by the hours exposed to sun light, then multiply the result by 0.85(this factor allows for natural system losses)

For the solar 40w panel in 4 hours sunshine,

40*4*0.85= 136wh

For 1 hour,

40*1*0.85 = 34wh

So, the solar panel of 40w is selected.

4. SET -UP AND WORKING

In this setup, we are using components like:

Solar panel:

Material used: Polycrystalline

Capacity: 40 Watt-12 Volt

Power: 40

Output voltage: 12

Length: 40 cm

Width: 65 cm

Weight: 2 Kg

Charge controller:

Dimensions: 7.2 * 14.5 * 13.7 Centimeters

Weight: 280 g

Battery:

Battery cell composition: Sealed Lead Acid
Weight: 9 Kg
Battery capacity: 12v-10Ah

Inverter:
Dimensions: 35 * 34 * 20 Centimeter
Weight: 15 Kg 800 g / Capacity: 12 Volt

4.1 3d Views setup

1) Front view of air cooler

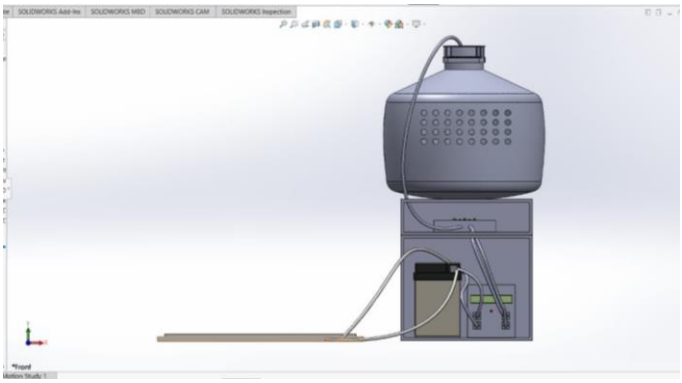


Fig-8: Front view

2) Side view of air cooler

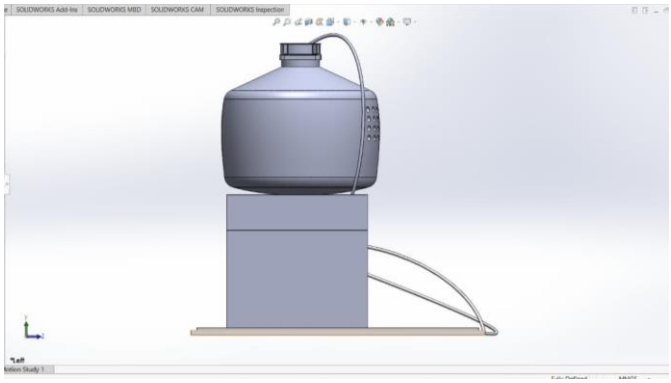


Fig-9: Side view

3) Top view of air cooler

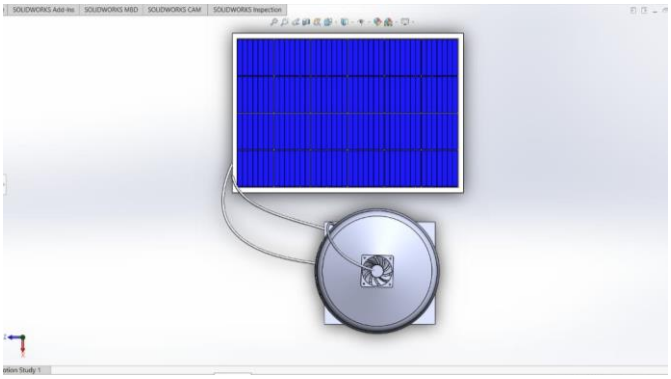


Fig-10: Top view

4.2 Isometric view of setup

1) Isometric view

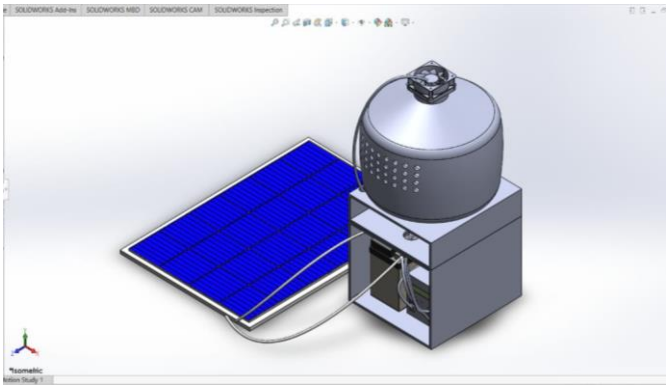


Fig-10: Isometric view

5. WORKING

This project is basically designed for domestic purpose. It reduces temperature of room. It contains solar panel which is acting as energy consumer from the sun and it is relevant component which is works on natural energy to reduce global warming. Solar panel is connected to battery which is main energy storage device. It stores the energy in form of DC, then this energy further transfers to inverter.

Inverter is the device which converts direct current to alternate current. It helps to stabilize the current. It protects the device variations in current. Generally domestic appliances need alternate current.

Moreover, the alternate current passed towards controller. Controller is device which controls the variations of current which passes towards the fan. Afterwards fan acts as air medium which is generate air in mud pot. And mud pot is water storage as well as cooling unit. It is generally porous in nature so it helps to reduce the room temperature.

In actual working, we are going to fill the mud pot with water below the ventilation holes, then solar panel consumes sunlight through solar cells. Then this energy will transfer towards battery in the form of DC supply. This DC energy further supply to inverter which alter the energy to AC supply. Then it sends towards the controller (control switch) and it forwards the required amount of current to next system which is fan, then fan starts rotating this results air is generate.

Eventually, after the air generation that air will comes in contact with water & water will get converted

into small droplets. These small droplets get mix with the air, this mixed air throws outside by given holes. simultaneously outside air gets entered into mud pot which cools the inside stored water which results it delivers chilled air to room. This feels human more comfort in affordable cost.

6. CONCLUSION

The comparing cost of this product with existing products in the market is appeals better and affordable by common people. This solar air-cooling product perfectly suits for village, school and offices or any domestic purpose, thus an alternative to the village on power failure. It is ecofriendly and natural and also it saves electricity. Durability of the product is more thus it minimizes the maintenance cost.

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